PowerTrunk

TETRA and Synchronous Data Manager (SDM) for Optimizing Public Transit Vehicle Location Systems

Keith Ammons
VP Market Development
PowerTrunk, Inc.

Introduction

- ❑ What is TETRA?
- ❑ Optimizing AVL for Public Transit
- ❑ Data polling process in TETRA
- ❑ Synchronous Data Manager (SDM)
- ❑ Reference cases

About PowerTrunk

Comprehensive Land Mobile Radio Solutions

- Subsidiary of Teltronic, S.A.U., a major global LMR vendor.

- 100% IP/Ethernet platforms.

- Complete infrastructure, subscriber radios, and CAD consoles

- 40 years experience in engineering, design, manufacturing implementation, and support

Worldwide Reputation

Tested – Proven - Trusted.

- More than 300 systems installed in over 50 countries.
- Expertise in communications systems for utilities, public safety, transportation, oil & gas, and industry.
- Delivery of turn-key solutions.
- Technological independence.
- Readiness to customize.

Global Presence
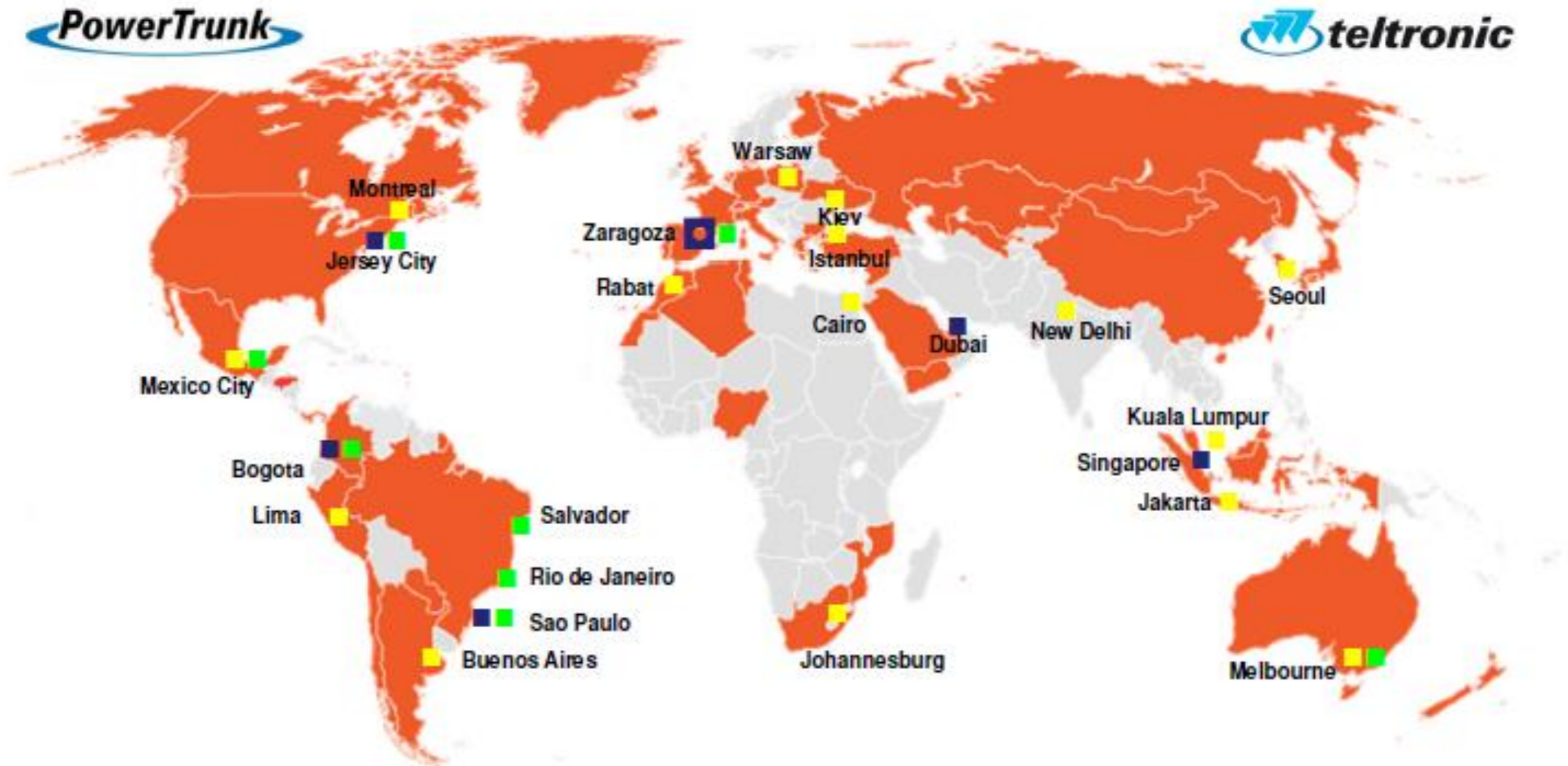
©PowerTrunk Inc

www.PowerTrunk.com

Transportation Sectors

Metros / Subways

Trams

Railroads

Buses

What is TETRA?

❑ An open standard for digital Land Mobile Radio (LMR) published by the European Telecommunications Standards Institute (ETSI)

❑ Originally developed for mission-critical public safety communications, later adopted for use by other sectors (transport, utilities, industry, oil & gas, etc.)

❑ Is the Nº 1 digital LMR technology in use in the world today (over 2 million users in 127 countries)
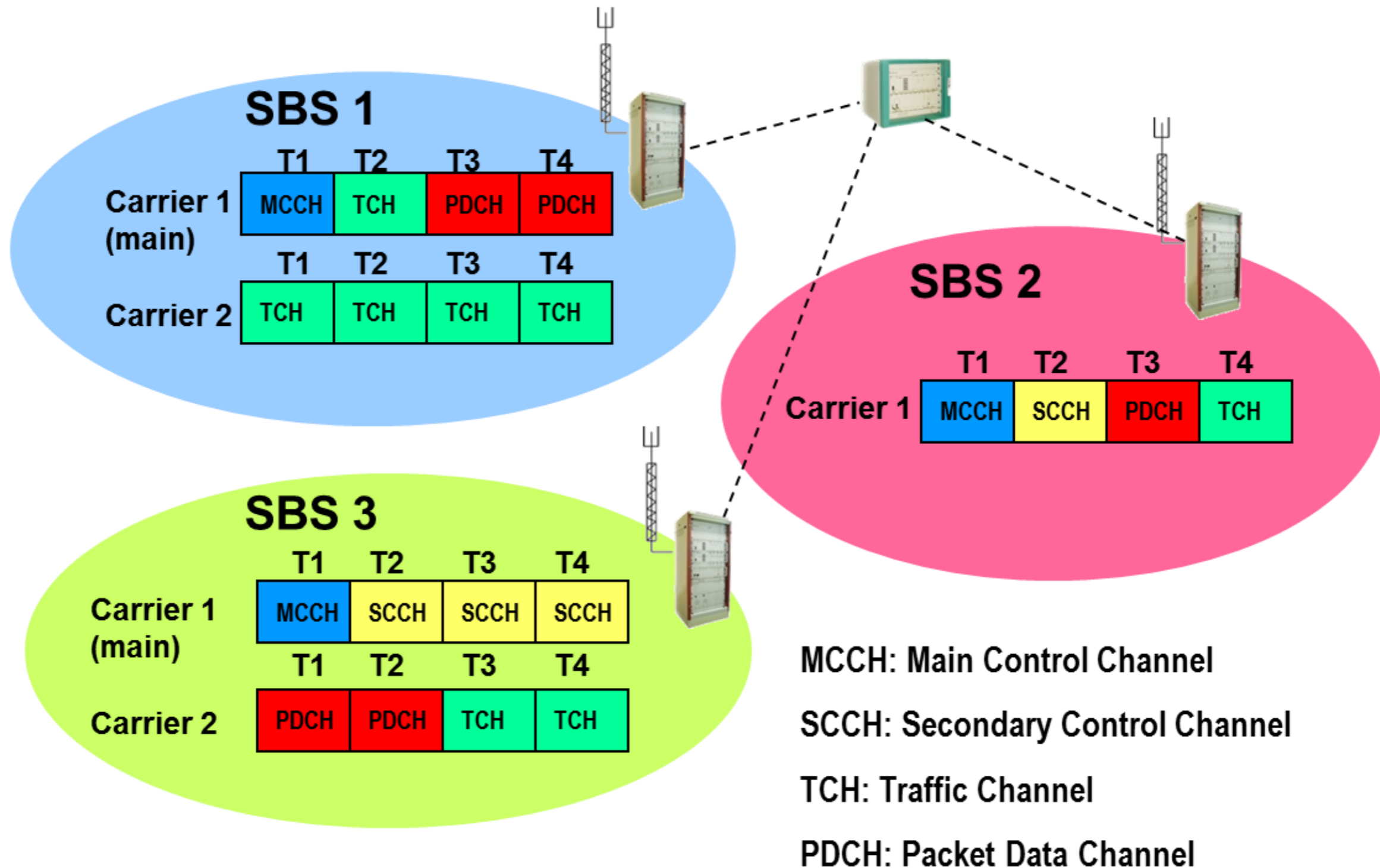
Why TETRA?

- ❑ Excellent cellular-like speech quality
- ❑ Feature-rich
- ❑ Voice + Data services
- ❑ Supports simultaneous voice and data in the same network
- ❑ Peripheral Equipment Interface (PEI)
- ❑ Up to twice the data capacity compared to other LMR technologies
- ❑ Open standard = Multivendor = Choice

Standard TETRA Data Services

PowerTrunk

- Status: 16 bits numeric message over control channel
- Short Data Service: 4 types according to message length.
  Sent over control channel.
  Implementation of type 4 supported by all manufacturers. Types 1, 2, and 3 optional.
  - *SDS type 4:* *255 bytes (140 characters)*
  - *Types 1, 2, 3:* *16, 32, and 64 bits, respectively*

- Circuit mode data: Transparent data. Requires traffic channel.
  Unprotected, 7.2 kbps single-slot,
  14.4 kbps 2-slots, or 28.8 kbps 4-slots data.
- Packet data: TCP/IP data. Requires traffic (data) channel.
  Single-slot or multi-slot.

TETRA General Concepts

Example of channel distribution

SBS 1

	T1	T2	T3	T4
Carrier 1 (main)	MCCH	TCH	PDCH	PDCH
Carrier 2	TCH	TCH	TCH	TCH

SBS 2

	T1	T2	T3	T4
Carrier 1	MCCH	SCCH	PDCH	TCH

SBS 3

	T1	T2	T3	T4
Carrier 1 (main)	MCCH	SCCH	SCCH	SCCH
Carrier 2	PDCH	PDCH	TCH	TCH

MCCH: Main Control Channel

SCCH: Secondary Control Channel

TCH: Traffic Channel

PDCH: Packet Data Channel

Optimizing AVL

❑ Automatic regulation:

- ▪ Efficiency mostly depends on the polling refresh rate that can be achieved

❑ Legacy solutions:

- ▪ Low channel capacity, slow data rates

❑ TETRA = TDMA

- ▪ Time Division Multiple Access
- ▪ 4 time slots in 25 KHz radio channel (up to 28.8 kbps)
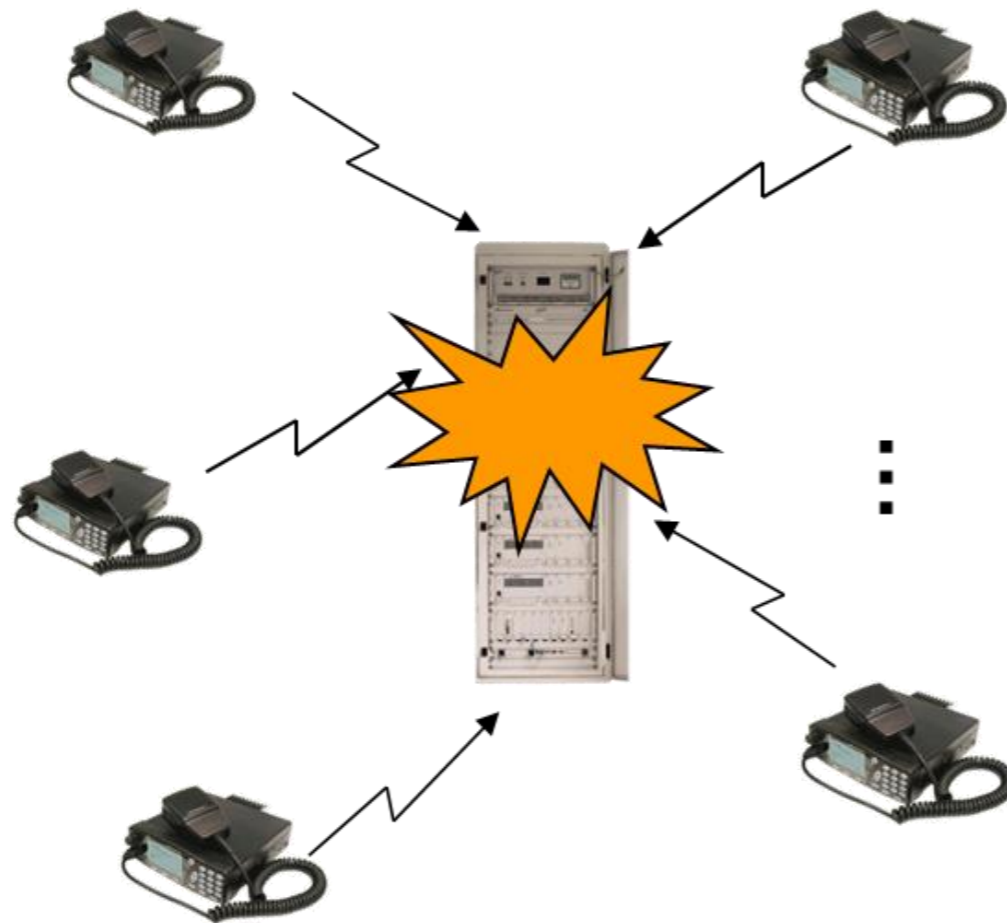- ▪ FCC narrowband compliant (6.25 KHz equivalence)

How to optimize?

POwerTrunk

Slotted Aloha method

Standard procedure for the massive and random access of subscriber terminals in a trunked communication system

Transmission by Subscribers to Base Station

Shared link between subscribers and Base Station

↓

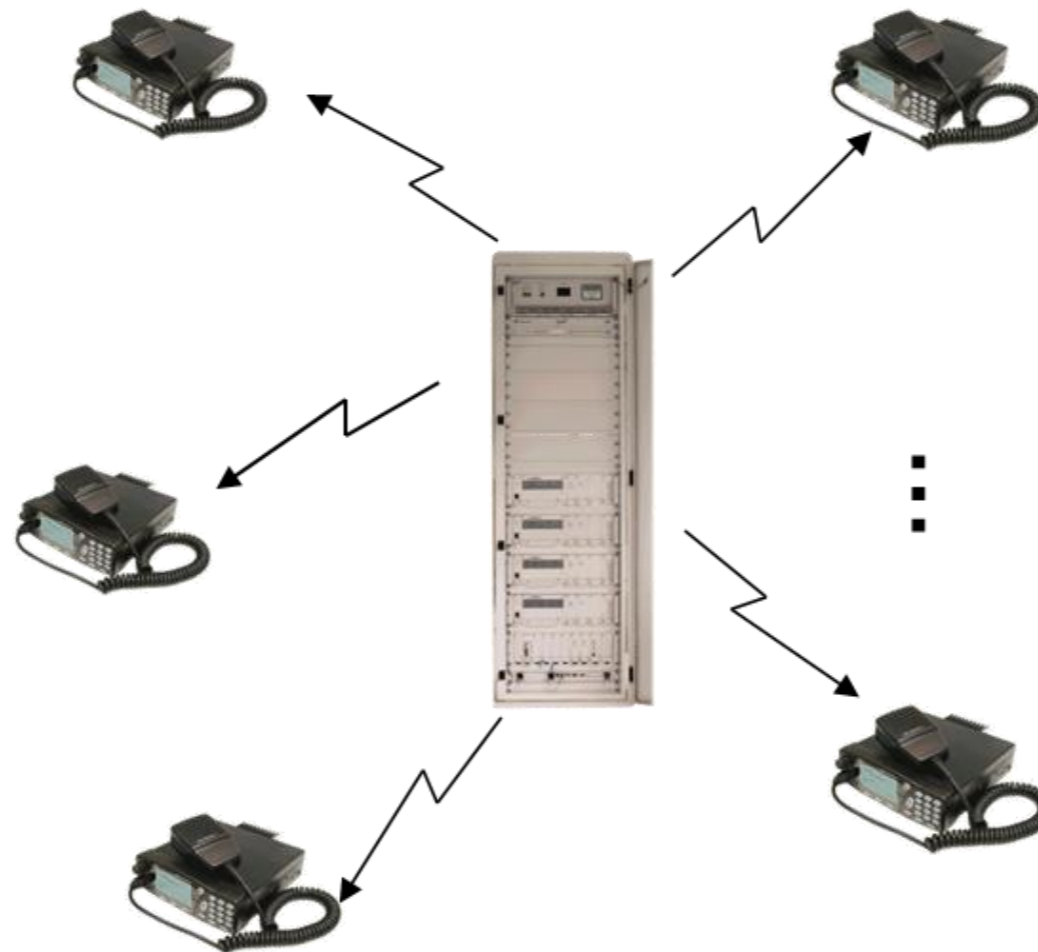Collisions in the air interface due to concurrent access attempts

↓

Susceptible to saturation in high-traffic networks

Call Access (downlink)

Transmission from Base Station to Subscribers

Dedicated link from Base Station to subscribers

100 % efficiency in the downlink

Therefore, a controlled polling method is more efficient than by random data transmission by the subscriber radios.

Data Polling With SDS

Standard TETRA SDS Solution

❑ Based on:

- TETRA Short Data Service (SDS) for polling and transmitting GPS positions in Location Information Protocol (LIP) format.

❑ Polling:

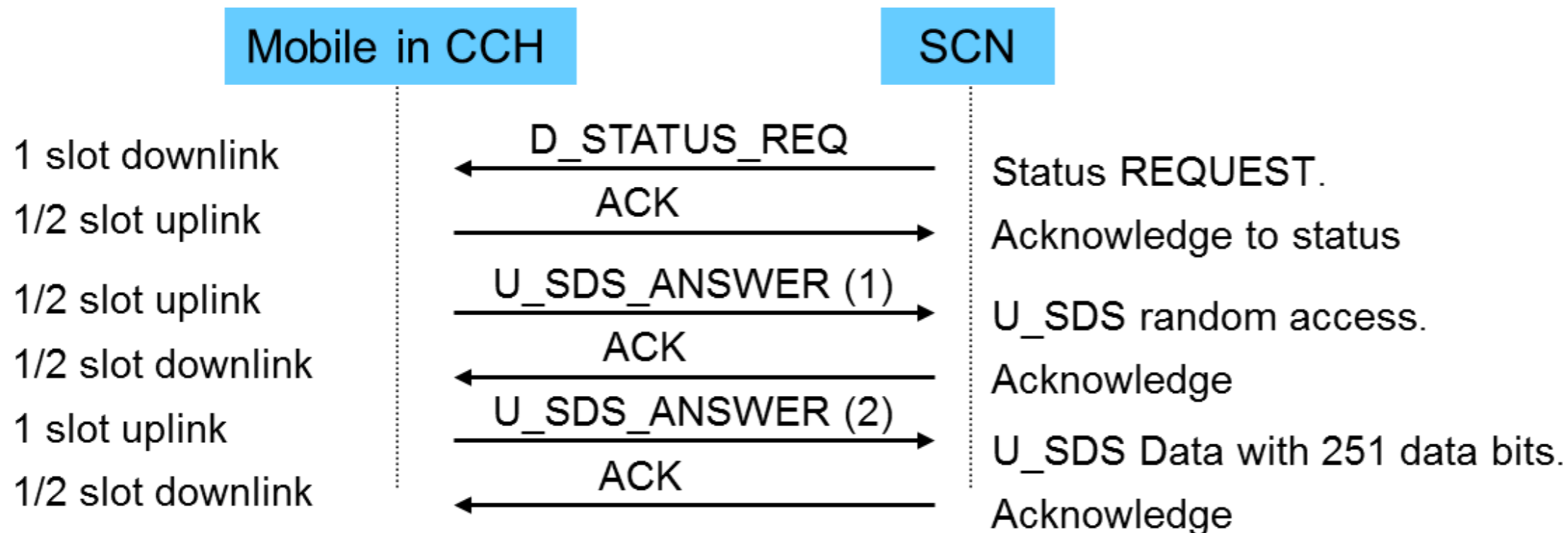- The fastest rate is 1 position every 0.6 seconds (multiplied by total number of users).

❑ Main advantage:

- Supported by all TETRA radio manufacturers

❑ Disadvantage:

- Susceptible to saturation in large networks.

SDS Call Process

Packets used in control channel to transmit 20 bytes of data:

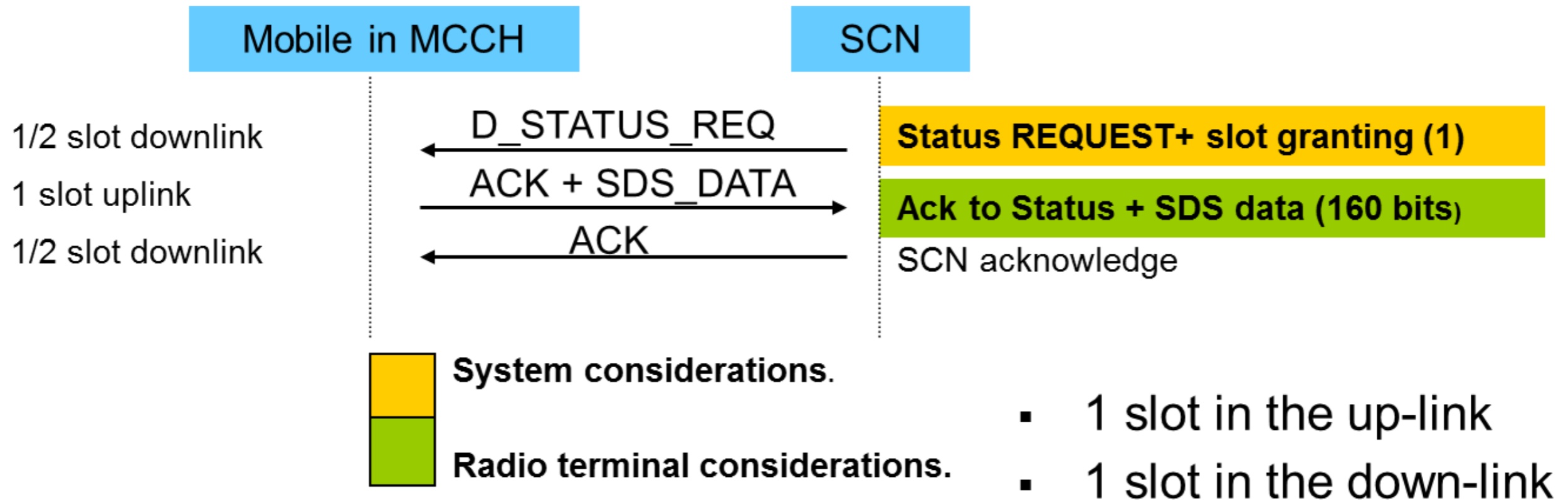|	Mobile in CCH	→	SCN	
1 slot downlink		D_STATUS_REQ ←		Status REQUEST.
1/2 slot uplink		ACK →		Acknowledge to status
1/2 slot uplink		U_SDS_ANSWER (1) →		U_SDS random access.
1/2 slot downlink		ACK ←		Acknowledge
1 slot uplink		U_SDS_ANSWER (2) →		U_SDS Data with 251 data bits.
1/2 slot downlink		ACK ←		Acknowledge

- 2 slots in the up-link
- 2 slots in the down-link

Can traffic efficiency be improved?

Synchronous Data Manager

PowerTrunk Optimized SDM Solution

❑ Synchronous Data Manager (SDM) based on:

- Use of TETRA SDS and LIP, with additional reservation of air resources.

- Synchronization of GPS polling at base stations.

❑ Polling:

- Up to 5 polls per second per control channel (MCCH/SCCH)

- Backward compatible with standard SDS polling

❑ SDM advantages:

- Acts in parallel in all coverage zones.

- Eliminates call collisions in uplink (synchronous)

SDM Uplink Improvement

Mobile in MCCH		SCN

1/2 slot downlink   ← D_STATUS_REQ   **Status REQUEST+ slot granting (1)**

1 slot uplink   → ACK + SDS_DATA   **Ack to Status + SDS data (160 bits)**

1/2 slot downlink   ← ACK   SCN acknowledge

System considerations.

Radio terminal considerations.

- 1 slot in the up-link
- 1 slot in the down-link

Result:

1) Slot granting in the status request guarantees synchronous transmission of the SDS data sent by the radio terminal ⟹ Suppression of collisions

2) Decrease in the data traffic necessary between radios and the Base Station

⟹ **100 %** efficiency in the up-link

SDM Downlink Improvement

❑ The system uses the ISSI list to poll all control channels in the network simultaneously

- ▪ The network knows where all units are located, so requests all positions at the same time through an internal data table
- ▪ Massive polling by tables instead of individual units

These three ISSI lines will be polled by the system in one second

In 20 seconds, all ISSIs on the table are sent to the base stations to poll the entire user fleet

SBS1 MCCH	SBS1 SCCH1	SBS1 SCCH2	SBS1 SCCH-B	SBS2 MCCH	....	SBS8 MCCH	SBS8 SCCH1	SBS8 SCCH2	SBS8 SCCH-B
70030	89903	34990	32122	08578	....	32890	38767	9009	3487
98439	33432	88998	83439	34343	....	34788	43433	34988	4938
34897	34676	34657	34686	34577	....	43789	43763	34876	34767
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
.	.	.	.	.	.	.	.	.	.
43677	34768	34566	34777	76667	....	36776	47767	3476	33344
467	34553	33763	33		....				46673
33878	78898	3433	6676		....				46766
	34786		6763		....				66667
	87555				....				53466
	67657				....				53443
					....				34674

Barcelona Metropolitan Transport

PowerTrunk

TMB
Transports Metropolitans
de Barcelona

1300 buses, positions updated in **20-30 sec.**

www.PowerTrunk.com

Barcelona Metropolitan Transport

❑ TETRA solution for positioning and regulation of fleet of 1300 buses.

❑ Complete coverage of Barcelona: 9 SBS

❑ Status and SDS messages

❑ Position updates every 20 – 30 seconds

❑ Voice communication with control center

❑ Interaction with Passenger Information System

Transmilenio, Bogota

1621 buses, **1.4** million passengers/day

Transmilenio, Bogota

- ❑ Integrated Public Transport System
- ❑ GPS positioning / fleet regulation every 20 sec.
- ❑ Control center with 7 operators
- ❑ Integration with 356 information panels at the bus stops

Mexico City Metro

Mexico City Metro

- ❑ TETRA coverage for Line B & Line 12
- ❑ SDM application for real-time train monitoring (balises / beacons, train ID, alarm status, etc.)
- ❑ CeCo-TRANS system: Dispatch communication module and train synoptic display
- ❑ Customized on-board equipment (railway standard compliant, special driver interface, ...)

Mexico City Metro

New Jersey Transit

❑ First TETRA network in the United States

❑ Largest statewide transit agency in US

New Jersey Transit

- ❑ SDM implemented
- ❑ Used during 2014 Super Bowl to provide GPS data to third-party location application
- ❑ Current use of SDM limited until full network roll-out completed
- ❑ Will eventually support tracking of over 4000 GPS equipped TETRA radios
- ❑ Mobile telemetry with SDM also to be implemented for monitoring vehicle status and on-board systems

Conclusions

- ❏ Transit systems have highly demanding communication requirements for their fleets
  - ▪ Dispatch, vehicle tracking, monitoring, …
- ❏ TETRA is ideally suited to meet these needs
  - ▪ Mature, proven, feature-rich, data capability
  - ▪ Simultaneous voice and data services
- ❏ Why SDM?
  - ▪ Value added, optimized solution for GPS polling and telemetry applications over LMR network
  - ▪ Up to 60% more efficient use of resources
  - ▪ Faster and more cost effective

Thank you for your attention

www.powertrunk.com